Regular Article
pISSN: 2288-9744, eISSN: 2288-9752
Journal of Forest and Environmental Science
Vol. 30, No. 3, pp. 253-258, August, 2014
http://dx.doi.org/10.7747/JFS.2014.30.3.253

JFES
Journal of Forest and Environmental Science

Status, Distribution, Conservation and Use Value of Medicinal and Aromatic Plants (MAPs) in Sagarmatha National Park, Nepal

Damodar Gaire*
Biodiversity Research and Conservation Society, 44600 Kathmandu, Nepal

Abstract

The study attempts to assess the status, distribution, conservation and use value of Medicinal and Aromatic Plant (MAPs) in the Sagarmatha National Park. Altogether 62 species of MAPs belonging to 47 genera and 33 families have been recorded in the study area. 10 species, belonging to 9 families are categorized as the potential species. Out of the these species, most potential in local but threatened species are *Allium hypsistum* Stearn, *Cordyceps sinensis* Sacc, *Dactylorhiza hatagirea* Soo, *Nardostachys grandiflora* DC, *Aconitum orochryseum, Ephedra gerardiana* Wall. Ex. *Stapf, Swertia multicaulis* D. Don, *Picrorhiza scrophulariflora* Penne, *Rheum australe.* D. Don, *Malva verticillataL and Swertia pedicallata* Benerji. By analysis of data using Simpson's diversity index (SI) and Shannon weaver function (H'), there was high diversity (more heterogeneous) MAPs species composition in the Manjo Gate to Large Dobhan. (0.98349). Less diversity (less heterogeneous) MAPs species composition was in Tyanboche to Pangoche (0.90419). Similarly, the Shannon weaver function shows that in plots laying out in Mongla to Phorche are evenly distributed than others However, higher MAPs species (i.e., 31) was found in the way of Manjo Gate to Larja Dobhan than others.

Key Words: status, distribution, conservation, threatened species, domestication

Introduction

Nepal comprises 0.1% of the earth's land area yet it ranks within the first quartile for global biodiversity importance (BPP 1995). This is because of its unique bio-geographic location, altitudinal variation and diverse climatic and topographic conditions. Out of 6,500 flowering plants found in the country, more than 700 species are recognized as non-timber forest products1 (NTFPs) and about 100 species of these are commonly traded (BPP 1995; Edward 1996). At least 1,600 to 1,900 species of plants are commonly used in traditional medicinal practices in Nepal (Baral 2006; Ghimire 2008). More than 75% Nepalese people still depend on the herbal plants as a local source of medicine for their primary health care (Dutta 2007). It has been regarded as "the Natural Showroom of Biodiversity" because of its geographical and ecological variation along with similar variation in climate. The altitudinal gradient resulting in environmental diversity gave Nepal's ecosystem a unique wealth and variety. Thirty five different types have been identified in Nepal by Stainton J.D.A (Stainton 1972). Nepal's protected areas cover 34,185.62 sq. km (23.23%) of the total geographical area of the country (DNPWC 2012). The Sagarmatha National Park was established in 1976 with the prospective view of preserving unique fragile mountain ecosystem and indigenous Sherpa

Received: July 31, 2013. Revised: January 2, 2014. Accepted: January 8, 2014.

Corresponding author: Damodar Gaire
Biodiversity Research and Conservation Society, 44600 Kathmandu, Nepal
Tel: 977-01-5538758, Fax: 977-9851148447, E-mail: d.gaire@yahoo.com

culture for years to come (Mishra 1972; Jefferies 1982). Habitat type ranges from the dense tropical and temperate regions, and family to the sub-alpine pastures and snow covered Himalayan peaks. Estimates vary as to the number of plant species contained in these and other ecosystems (Hara and Willams 1978; 1979). The Sagarmatha National Park is a dramatic area of high, geologically young mountains and glaciers. In the region there are six altitudinal vegetation classed, from oak forests at the lowest elevations to lichens and mosses at the highest elevations. Most of the park (69%) comprises barren land above 5,000 m, 28% is grazing land and about 3% is forested. Six of the 11 vegetation zones in the Nepal Himalaya is represented in the park: lower subalpine; upper subalpine; lower alpine; upper alpine; and subnival zone. Oak used to be the dominant species in the upper Montane zone but former stands of this species (UNESCCO 2013). Over harvesting of resources in many cases has made them rare in the wild, in some cases threatening or even dangering their status. To minimize such threat, measures taken by the Government include putting a ban on the collection of resources or restricting their export in raw form. 60 species of non-endemic plants of Nepal are considered as threatened (Shrestha and Joshi 1996). Therefore, the study was carried out with the objective of listing out the potential Medicinal and Aromatic Plants found in the study area, determining the status & distribution of major potential MAPs (*i.e.* Density, frequency, abundance, Simpson's diversity index, Shannon weaver function), finding out issues on conservation of MAPs from the study area and documenting the ethno-botanical uses of MAPs in the Sagarmatha National Park.

Materials and Methods

Study area

Sagarmatha National Park is located to the northeast of Kathmandu in the Kumbu region of Nepal. The park includes the highest peak in the world, Mt. Sagarmatha (Everest), and several other well-known peaks such as Lhotse, Nuptse, Cho Oyu, Pumori, Ama Dablam, Thamserku, Kwangde, Kangtaiga and Gyachung Kang. The study was conducted in Sagramatha NP (From Manjo Gate to Pyanboche Gumba).

Data collection procedures

Primary data were collected to order to capture the real facts, and analyze the current status of medicinal and aromatic plants. Key informant's survey was carried out by older persons, local Amze and other Sherpa women who indirectly involve in the traditional curing system from MAPs. Participatory resource mapping was carried out in a group meeting in the Phorche, Tyanboche and Dingboche to assess the MAPs. Moreover, Rapid Vulnerability Assessment (RVA) was used to collect the information about identifying species, resources or sites that may be at risk of over exploitation (Jenifer 2001). The inventory was carried out to assess the status, distribution and conservation and use value of MAPs for the baseline information on the Sagarmatha National Park. The method adopted was systematic method (as inventory guideline of Department of Forest). Every sampling plot size was taken as 25 m*20 m dimensions and within the plot 25 m*20 m was for trees, 5 m*5 m for shrubs, and 1 m*1 m for herb species. Tracing route had been considered a transect line and uniform distance were determined with the help of the GPS and inventory of potential MAPs were carried out. The majority of the plots were in herbs and shrubs categories.

Data analysis

In order to compare the distribution pattern in different blocks, either there is heterogeneous or homogenous & even or uneven distribution; Simpson's index and Shannon Weaver function were calculated using the following formulae:

$$SI = \frac{\sum n1\,(n1-1)}{N\,((N-1))}$$

Where, SI=Simpson's diversity index, N =total no. of individuals of all species, n1=number of individuals belonging to a species i and i=1 to k, and k= total no. of species.

Simpson's index varies inversely with heterogeneity i.e., index values decrease (or increase) as diversity increase (or decrease) i.e. higher (or lower) index probability values correspond to higher (or lower) diversity values. Simpson's index was subtracted from its maximum possible value of 1

(Pielou et al. 1977; Schemnitz 1980). For a random sample with an infinitely large population, Simpson's index of diversity was calculated as:

$$D=1-SI$$

Simpson's index is most appropriately used when the relative degree of dominance of a few species in the community is the primary interest, rather than the overall evenness of the abundance of all species.

Shannon Weaver function was calculated using the following formulae:

$$H'=-\sum pi*\log 2pi$$

Where, H=Shannon Weaver function, pi=Proportion of total no. of individuals that occur in the species I i =1 to k, k is the total no. of species, N=total no. of individuals of all species in the sample

Results and Discussion

Diversity of medicinal and aromatic plants (MAPs)

Sagarmatha NP has altitudinal variation of 2,800 (Manjo Gate) to lap of the Mt. Everest (8,848 m). It has resulted diverse geographical conditions in the area of temperate forest at the Manjo Gate to alpine zones above 4,500 m. The summary of the diversity has been presented below (Refer to the Table 1):

Table 1. Table diversity of the MAPs species

S.N.	Categories	Number
1.	Total species of MAPs	62
2.	Total family represented	33
3.	Total genera represented	47
4.	Total tree species	4
5.	Total shrub species	18
6.	Total herb species	40

Analysis of diversity and availability of MAPs of the study sites

Simpson's diversity index (SI) and Shannon weaver function (H') are used to analyze the diversity and availability of MAPs, which are important powerful diversity indices. The Table 2 has been focused on showing the Simpson's diversity index (SI) and Shannon weaver function (H').

By analysis of data using Simpson's diversity index (SI) and Shannon weaver function (H'), there was high diversity (more heterogeneous) MAPs species composition in the Manjo Gate to Larja Dobhan (0.98349). Less diversity (less heterogeneous) MAPs species composition was in Tangboche to Pangoche (0.90419). Similarly, the Shannon weaver function shows that in plots laying out in Mongla to Pthorche are evenly distributed than others, however, higher MAPs species (i.e., 31) was found in the way of Manjo Gate to Larja Dobhan than others.

Use value of medicinal and aromatic plants (MP)

The use values of MAPs have been categorized according to the indigenous knowledge in the study area (See the Table 3).

Habitat and distribution

In the present study, Medicinal and Aromatic Plants (MAPs) were recorded from 2,800 m to 4,300 m altitude (See the Table 4). Jartamansi (*Nadostachy grandiflora*), Kutki (*Picrorhiza scrophulariflora*), Nirmansi (*Aconitum or-*

Table 2. Diversity and availability of MAPs

Blocks	SI	D	H'	Total no. of species
Manjo Gate to Larja Dobhan	0.01651	0.98349	3.08696	31
Larja Dobhan to Namche	0.02455	0.97545	3.84961	29
Namche to Mongla	0.05172	0.94828	3.99998	15
Mongla to Phorche	0.06895	0.93105	5.29159	20
Phorche to Tyanboche	0.08434	0.91566	2.77663	12
Tyanboche to Pyanboche	0.09581	0.90419	2.50798	11

Table 3. Locally uses some MAPs in different medicinal sub-use categories in the study area

S. N.	Medicine sub-use category	Disorders treated/medicinal effects	Body parts/treated	Species
1.	Endocrine system disorders	Diabetes	Endocrine system	*Nardostachy grandiflora* DC
2.	Inflammation	Sore throat		*Picrorhiza scrophulriiflora*
		Sore throat		*Rheum australe*
3.	Skin/subcutaneous cellular tissue disorders	Antiseptic	Skin	*Betua utilis*
		Skin disease		*Junipers species*
4.	Injuries	Cuts		*Picrorhiza scrophulariiflora* Pennel
		Cuts		*Rheum australe D.Don*
		Wounds, Burns		*Dactylorhiza hatagirea*
5.	Pain	Body pain		*Rumax nepalensis*
		Headache		*Gentiana capitata*
		Headache		*Swertia pedicellata*
6.	Inflections/Infestation	Anthelmintic		*Artemisia spps*
		Cold and fever		*Picrorhiza schophulariiflora*
		Dysentery		*Asparagus spps* (high altitude)
7.	Genitourinal system disorders	Aphrodisiac		*Cordyceps sinensis*
		Aphrodisiac		*Dactylorhiza hatagirea*
		Urinal trouble		*Malva verticillata L*
8.	Digestive system disorders	Carminative		*Betula utilis*
		Diarrhea		*Asparagus racemosus* Wild
		Piles		*Nadostachys grandiflora*
		Purgative		*Daphne bholua*
		Stomach disorder		*Pirorhiza scrophulariiflora*
9.	Poisoning	Antidote		*Aconitium spps*
10.	Respiratory system disorders	Asthma		*Ephedra gerardiana*
		Cough		*Anemone spps*
11.	Blood system disorders	Blood purifier		*Rhododendron spps*
		Blood disease		*Rheum australe*
12.	Mental disorder	Mental disorder		*Nadorstachy grandiflora*
13.	Nutritional disorder	Tonic		*Cordypsis sinensis*
				Dactylorhiza hatagirea
14.	Muscular-skeletal system disorders	Fracture	Bone	*Rheum australe*
		Rheumatism		*Ephedra gerardiana*
15.	Others	Cancer		*Podophyllum hexandrum*
		Herbal tea		Himalayan Blue Poppy

ochryseum), panchaunle (*Dactylorhiza hatageria*), Padamchal (*Rheum australe*), Somlata (*Ephedra gerardiana*), etc. generally preferred the habitats located above tree line in sub-alpine Zones between 3,500 to 4,000 m altitude. Jimbu (*Allium hypsistum*) and Yarsa Gumba (*Cordyceps sinensis*) were heard in meadows of high alpine zone from 4,000-5,000 m altitude according to the key informants survey. Padamchal (*Rheum austral* D.Don) was recorded in the open slope from 3,300 to 4,000 m and Panchaunle was recorded in the open slope from 3,500 to 4,000 m.

According to the key informant's survey, Jatamansi and Kutki can be found in an association. One thing that must be considered as Jatamansi was noticed in the field on more steeply rocky slopes than the Kutki. Nirmansi was abundant in open meadows. Associated with other vegetation like *Rhodendron spps* and *Primula sikkimensis*. *Ephedra gerardiana* preferred dry and open sunny places; therefore, it was not associated with other medicinal plant species.

Table 4. Habitat distribution of 10 important MAPs

S.N	Species	Nepali Name	Family	Altitude (m)
1	*Allium hypsistum* Stearn	Jimbu	Liliaceae	4,000-4,500
2	*Cordyceps sinensis* Sacc	Yarsagumba	Hypocreaceae	4,500-5,200
3	*Dactylorhiza hatagirea* Soo	Panchaunle	Orchidaceae	3,000-4,500
4	*Nardostachys grandiflora* DC	Jatamasi	Valerianaceae	3,200-5,000
5	*Aconitum orochryseum*	Nirmansi	Ranunculaceae	3,500-4,100
5	*Ephedra gerardiana* Wall. Ex. Stapf	Somlata	Ephedraceae	3,500-4,500
6	*Swertia multicaulis* D. Don	Sharmaguru	Gentinaceae	4,000-4,500
7	*Picrorhiza scrophulariflora* Penne	Kutki	Scrophulariaceae	4,500-5,000
8	*Rheum australe.* D. Don	Padamchal	Liliaceae	3,000-4,500
9	*Malva verticillata*L	Chyampa	Mavaceae	3,200-4,500
10	Swertia ped icallata Benerji	Saumjutica	Gentianaceae	4,500-5,000

Table 5. Threatened medicinal and aromatic plants found in Sagarmatha National Park

S.N.	Species	IUCN	HMGN	CITES	Local status	Remarks
1.	*Cordyceps sinensis* (Berk.) Sacc	CT			Near threatened	Threatened due to excessive collection and highly used in sexual perspective
2.	*Dactylorhiza hatagirea* Wall ex Kunth		I	II	Rare	Threat due to illogical collection and due to habitat destruction
3.	*Nadostachys grandiflora* DC	V	II	II	Threatened	Threat due to extensive collection, uprooting
4.	*Paris polyphylla* Smith	V			Common	Habitat destruction
5.	*Picrorhiza scrophulariiflora* Pennel	V		II	Not so common	Extensive collection by local Lama
6.	*Valeriana jatamansi* Jones		II		Not common	Habitat destruction

Note: where, V=Vulnerable and CT=critically threatened.

Conservation status of medicinal and aromatic plants (MAPs)

A total of 6 species of medicinal and aromatic plants was recorded in the study area which have already been included under the threatened and protected list of IUCN and HMGN, forest Act (1993) respectively. Out of Six species, four species have been included under the threatened list of IUCN of which one species to critically threatened categories. Besides four species of plants belonging to HMGN protected category and three species fall under the Convention on International Trade in Endangered Species (CITES) Appendix II (See the Table 5).

Determine the causal factors for MAPs depletion

Causal factors of MAPs depletion were determined through household surveys by questionnaire, key-informant survey, discussion with stakeholders and field observations. Among 83 respondents, 11 emphasized continuous and uncontrolled fire as the causal factors of MAPs depletion. Similarly, 5 for grazing, 4 for illegal felling, 20 for illegal harvesting practices, 20 for lack of awareness on MAPs conservation, 4 for lack of monitoring and supervision, 9 emphasized the grazing by yaks and 10 for lack of people's participation in MAPs conservation, utilization and management were the main causal factors pointed out by the respondents.

Conclusions

A total of 62 species of Medicinal and Aromatic Plants (MAPs) belonging to 47 genera and 33 families has been recorded from the study area. Out of these, a total of 10 species belongings of 9 families have been categorized as the potential species in terms of their contribution to the local health care. National and man-made disturbances such

as harvesting for trade, habitat encroachment for agriculture, deforestation, grazing etc. are the major factors responsible in the loss of many potential Medicinal and Aromatic Plants (MAPs) in Sagarmatha National Park. During the study period, species like *Cordypsis sinensis Sacc, Picrorhiza scrophulariflora Panne, Swertia multicaulis D. Don and Dactylorhiza hatagirea Soo* have been recorded as under the great threats. By analysis of data using Simpson's diversity index (SI) and Shannon weaver function (H'), there was high diversity (more heterogeneous) MAPs species composition in the Manjo Gate to Larja Dobhan (0.98349). Less diversity (less heterogeneous) MAPs species composition was in Tyanboche to Pyanboche (0.90419). Similarly, the Shannon weaver function shows that in plots laying out in Mongla to Phorche are evenly distributed than others However, higher MAPs species (i.e., 31) was found in the way of Manjo Gate to Larja Dobhan than others. The conservation of MAP germplasms in natural parks, equivalent reserve and botanical gardens has been quite successful in Nepal. But, at the genetic level more effort would be necessary, especially in conservation and cultivation of commercially potential MAPs species on a large scale. The results explore the general baseline information about MAPs species which definitely contributes to the conservationists, ecological organizations and local people.

Acknowledgement

My special thanks go to Mr. Achyut Gyawali (Research Supervisor), Mr. Ek Raj Sigdel (TRPAP), Dr. Sherab Tenzin Barma (Local Amze), Mr. Tenzin Norbu Sherpa (Director of Sacred land initiatives, High altitude Medicinal Herb Plantation, Pharmacy, Clinic and Research Centre), Mr. Palten Sherpa (Local Villager), Mr. Lakpa Sharpa (Field Assistant) and Mr. Autari Lama (Local Lama). My respectful acknowledgement goes to the Ministry of Forest and Soil Conservation (MFSC), British Ecological Society (BES), Tourism for Rural Poverty Alleviation Programme (TRPAP) for providing the greatest opportunity in the high altitude research and financial support for accomplishing the study.

References

Baral SR, Kurmi PP. 2006. A compendium of medicinal plants in Nepal. Rachana Sharma, Kathmandu, Nepal.

Biodiversity Profile Project. 1995. Enumeration of the lichens of Nepal. Government of Nepal and Government of Netherlands, Kathmandu, Nepal.

Department of National Parks and Wildlife Conservation. 2012. Annual Report. Kathmandu, Nepal.

Dutta IC. 2007. Non Timber Forest Products in Nepal (Identification, classification, ethnic uses and cultivation), Hillside Press, Kathmandu, Nepal 1: pp 45-57

Edwards DM. 1996. Non-timber forest products from Nepal: aspects of the trade in medicinal and aromatic plants. Forest Research and Survey Centre, Ministry of Forests and Soil Conservation, Babar Mahal, Kathmandu, Nepal.

Ghimire SK. 2008. Sustainable Harvesting and Management of Medicinal Plants in the Nepal Himalaya: Current Issues, Knowledge Gaps and Research Priorities. Ecological Society of Nepal, pp 25-44.

Hara HL, Williams HJ. 1979. An Enumeration of the Flowering Plants of Nepal. British museum (Natural history), London, U.K.

Hara HL, Williams LHJ. 1978. An Enumeration of Flowering Plants of Nepal. London: Trustees of British museum (Natural history).

Jefferies BE. 1982. Sagarmatha National Park: the impact of tourism in the Himalayas. 11: 274-281.

Mishra HR. 1973. Conservation in Khumbu: The proposed Mt. Everest National Park, A Preliminary Report. Department of National Park and Wildlife Conservation, Kathmandu.

Pielou EC. 1977. Mathematical ecology. Wley & Sons, Incorporated, John publication, New York.

Schemnitz SD. 1980. Wildlife management techniques manual. Wildlife Society, Washington, D.C, pp 686.

Shrestha TB, Joshi RM. 1996. Rare Plants; Endemic Plants; Endangered Plants; Nature Conservation and Identification. WWF Nepal Program, Kathmandu, pp 244.

Stainton JDA. 1972. Forests of Nepal. John Murray, London, pp 174.

UNESCCO. 2013. United Nations Educational, Scientific and Cultural Organization and World Heritage Convention (WHC). http://whc.unesco.org/en/list/120.

Wong JLG, Thornber K, Baker N. 2001. Resource assessment of non-wood forest products: Experience and Biometric Principles. food and Agriculture organization of the United Nations, Rome.